

NODE=B011

 $\Delta(1905)$ 5/2⁺ $I(J^P) = \frac{3}{2}(\frac{5}{2}^+)$ Status: ***

Most of the results published before 1975 were last included in our 1982 edition, Physics Letters **111B** 1 (1982). Some further obsolete results published before 1984 were last included in our 2006 edition, Journal of Physics, G **33** 1 (2006).

NODE=B011

 $\Delta(1905)$ BREIT-WIGNER MASS

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1855 to 1910 (\approx 1880) OUR ESTIMATE			
1861 \pm 6	ANISOVICH	12A	DPWA Multichannel
1857.8 \pm 1.6	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1910 \pm 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1905 \pm 20	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1818 \pm 8	SHRESTHA	12A	DPWA Multichannel
1890 \pm 25	¹ ANISOVICH	10	DPWA Multichannel
1855.7 \pm 4.2	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
1873 \pm 77	VRANA	00	DPWA Multichannel
1895 \pm 8	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
1850	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1881 \pm 18	MANLEY	92	IPWA $\pi N \rightarrow \pi N & N\pi\pi$
1960 \pm 40	CANDLIN	84	DPWA $\pi^+ p \rightarrow \Sigma^+ K^+$
1787.0 \pm 6.0	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
1830	² LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

NODE=B011M

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→ UNCHECKED ←

 $\Delta(1905)$ BREIT-WIGNER WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
270 to 400 (\approx 330) OUR ESTIMATE			
335 \pm 18	ANISOVICH	12A	DPWA Multichannel
320.6 \pm 8.6	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
400 \pm 100	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
260 \pm 20	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
278 \pm 18	SHRESTHA	12A	DPWA Multichannel
335 \pm 30	ANISOVICH	10	DPWA Multichannel
334 \pm 22	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
461 \pm 111	VRANA	00	DPWA Multichannel
354 \pm 10	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
294	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
327 \pm 51	MANLEY	92	IPWA $\pi N \rightarrow \pi N & N\pi\pi$
270 \pm 40	CANDLIN	84	DPWA $\pi^+ p \rightarrow \Sigma^+ K^+$
66.0 \pm 24.0	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
220	² LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$

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→ UNCHECKED ←

 $\Delta(1905)$ POLE POSITION

REAL PART VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1805 to 1835 (\approx 1820) OUR ESTIMATE			
1805 \pm 10	ANISOVICH	12A	DPWA Multichannel
1819	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1829	³ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
1830 \pm 40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
1769	SHRESTHA	12A	DPWA Multichannel
1800 \pm 15	ANISOVICH	10	DPWA Multichannel
1825	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
1793	VRANA	00	DPWA Multichannel
1832	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1794	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
1813 or 1808	⁴ LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$

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-2×IMAGINARY PART

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
265 to 300 (≈ 280) OUR ESTIMATE			
300±15	ANISOVICH	12A	DPWA Multichannel
247	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
303	³ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
280±60	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
239	SHRESTHA	12A	DPWA Multichannel
300±20	ANISOVICH	10	DPWA Multichannel
270	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
302	VRANA	00	DPWA Multichannel
254	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
230	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
193 or 187	⁴ LONGACRE	78	IPWA $\pi N \rightarrow N\pi\pi$

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Δ(1905) ELASTIC POLE RESIDUE**MODULUS |r|**

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
20±2	ANISOVICH	12A	DPWA Multichannel
15	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
25	HOEHLER	93	SPED $\pi N \rightarrow \pi N$
25±8	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
16	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
12	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
14	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

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PHASE θ

VALUE (°)	DOCUMENT ID	TECN	COMMENT
-44± 5	ANISOVICH	12A	DPWA Multichannel
-30	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
-50±20	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-25	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$
- 4	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
-40	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90

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Δ(1905) INELASTIC POLE RESIDUE

The “normalized residue” is the residue divided by $\Gamma_{pole}/2$.

Normalized residue in $N\pi \rightarrow \Delta(1905) \rightarrow \Delta\pi, P\text{-wave}$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
25±6	0 ± 15	ANISOVICH	12A	DPWA Multichannel

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Δ(1905) DECAY MODES

The following branching fractions are our estimates, not fits or averages.

Mode	Fraction (Γ_i/Γ)
$\Gamma_1 N\pi$	9–15 %
$\Gamma_2 \Sigma K$	
$\Gamma_3 N\pi\pi$	85–95 %
$\Gamma_4 \Delta\pi$	<25 %
$\Gamma_5 \Delta(1232)\pi, P\text{-wave}$	
$\Gamma_6 \Delta(1232)\pi, F\text{-wave}$	
$\Gamma_7 N\rho$	>60 %
$\Gamma_8 N\rho, S=3/2, P\text{-wave}$	
$\Gamma_9 N\rho, S=3/2, F\text{-wave}$	
$\Gamma_{10} N\rho, S=1/2, F\text{-wave}$	
$\Gamma_{11} N\gamma$	0.012–0.036 %
$\Gamma_{12} N\gamma, \text{ helicity}=1/2$	0.002–0.006 %
$\Gamma_{13} N\gamma, \text{ helicity}=3/2$	0.01–0.03 %

DESIG=1;OUR EST
DESIG=2
DESIG=3;OUR EST
DESIG=181;OUR EST
DESIG=4
DESIG=5
DESIG=182;OUR EST
DESIG=7
DESIG=8
DESIG=6
DESIG=185;OUR EST
DESIG=9;OUR EST
DESIG=10;OUR EST

Δ(1905) BRANCHING RATIOS

NODE=B011230

 $\Gamma(N\pi)/\Gamma_{\text{total}}$

VALUE (%)
9 to 15 OUR ESTIMATE

	DOCUMENT ID	TECN	COMMENT	Γ_1/Γ
13 ± 2	ANISOVICH	12A	DPWA Multichannel	NODE=B011R1
12.2 ± 0.1	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$	NODE=B011R1
8 ± 3	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$	→ UNCHECKED ←
15 ± 2	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$	
• • • We do not use the following data for averages, fits, limits, etc. • • •				
6 ± 1	SHRESTHA	12A	DPWA Multichannel	
12 ± 3	ANISOVICH	10	DPWA Multichannel	
12.0 ± 0.2	ARNDT	04	DPWA $\pi N \rightarrow \pi N, \eta N$	
9 ± 1	VRANA	00	DPWA Multichannel	
12	ARNDT	95	DPWA $\pi N \rightarrow N\pi$	
12 ± 3	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$	
11	CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$	

 $(\Gamma_1\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1905) \rightarrow \Sigma K$

VALUE
 -0.015 ± 0.003

	DOCUMENT ID	TECN	COMMENT	$(\Gamma_1\Gamma_2)^{1/2}/\Gamma$
-0.015 ± 0.003	CANDLIN	84	DPWA $\pi^+ p \rightarrow \Sigma^+ K^+$	NODE=B011R2

Note: Signs of couplings from $\pi N \rightarrow N\pi\pi$ analyses were changed in the 1986 edition to agree with the baryon-first convention; the overall phase ambiguity is resolved by choosing a negative sign for the $\Delta(1620)$ S_{31} coupling to $\Delta(1232)\pi$.

 $(\Gamma_1\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1905) \rightarrow \Delta(1232)\pi, P\text{-wave}$

VALUE
 -0.04 ± 0.05

	DOCUMENT ID	TECN	COMMENT	$(\Gamma_1\Gamma_5)^{1/2}/\Gamma$
-0.04 ± 0.05	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$	NODE=B011R3

 $\Gamma(\Delta(1232)\pi, P\text{-wave})/\Gamma_{\text{total}}$

VALUE (%)
 45 ± 14

	DOCUMENT ID	TECN	COMMENT	Γ_5/Γ
45 ± 14	ANISOVICH	12A	DPWA Multichannel	NODE=B011R8
23 ± 1	VRANA	00	DPWA Multichannel	NODE=B011R8

• • • We do not use the following data for averages, fits, limits, etc. • • •

28 ± 7 SHRESTHA 12A DPWA Multichannel

 $(\Gamma_1\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1905) \rightarrow \Delta(1232)\pi, F\text{-wave}$

VALUE
 $+0.20$

	DOCUMENT ID	TECN	COMMENT	$(\Gamma_1\Gamma_6)^{1/2}/\Gamma$
$+0.20$	2 LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$	NODE=B011R4

• • • We do not use the following data for averages, fits, limits, etc. • • •

$+0.02 \pm 0.03$ MANLEY 92 IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

 $\Gamma(\Delta(1232)\pi, F\text{-wave})/\Gamma_{\text{total}}$

VALUE (%)
 44 ± 1

	DOCUMENT ID	TECN	COMMENT	Γ_6/Γ
44 ± 1	VRANA	00	DPWA Multichannel	NODE=B011R7

• • • We do not use the following data for averages, fits, limits, etc. • • •

64 ± 8 SHRESTHA 12A DPWA Multichannel

 $(\Gamma_1\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1905) \rightarrow N\rho, S=3/2, P\text{-wave}$

VALUE
 $+0.30 \text{ to } +0.36 \text{ OUR ESTIMATE}$

	DOCUMENT ID	TECN	COMMENT	$(\Gamma_1\Gamma_8)^{1/2}/\Gamma$
$+0.30 \text{ to } +0.36 \text{ OUR ESTIMATE}$	2 LONGACRE	75	IPWA $\pi N \rightarrow N\pi\pi$	NODE=B011R5

• • • We do not use the following data for averages, fits, limits, etc. • • •

$+0.33 \pm 0.03$ MANLEY 92 IPWA $\pi N \rightarrow \pi N \& N\pi\pi$

 $\Gamma(N\rho, S=3/2, P\text{-wave})/\Gamma_{\text{total}}$

VALUE (%)
 24 ± 1

	DOCUMENT ID	TECN	COMMENT	Γ_8/Γ
24 ± 1	VRANA	00	DPWA Multichannel	NODE=B011R6

• • • We do not use the following data for averages, fits, limits, etc. • • •

< 6 SHRESTHA 12A DPWA Multichannel

$\Delta(1905)$ PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition,
Journal of Physics, G **33** 1 (2006).

$\Delta(1905) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$

VALUE (GeV $^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
+0.026±0.011 OUR ESTIMATE			
0.025±0.004	ANISOVICH	12A	DPWA Multichannel
0.019±0.002	WORKMAN	12A	DPWA $\gamma N \rightarrow N\pi$
0.021±0.004	DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
0.021±0.010	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.043±0.020	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
0.066±0.018	SHRESTHA	12A	DPWA Multichannel
0.028±0.012	¹ ANISOVICH	10	DPWA Multichannel
0.018	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
0.022±0.005	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.055±0.004	LI	93	IPWA $\gamma N \rightarrow \pi N$

$\Delta(1905) \rightarrow N\gamma$, helicity-3/2 amplitude $A_{3/2}$

VALUE (GeV $^{-1/2}$)	DOCUMENT ID	TECN	COMMENT
-0.045±0.020 OUR ESTIMATE			
-0.049±0.004	ANISOVICH	12A	DPWA Multichannel
-0.038±0.004	WORKMAN	12A	DPWA $\gamma N \rightarrow N\pi$
-0.046±0.005	DUGGER	07	DPWA $\gamma N \rightarrow \pi N$
-0.056±0.028	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
-0.025±0.023	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
• • • We do not use the following data for averages, fits, limits, etc. • • •			
-0.223±0.029	SHRESTHA	12A	DPWA Multichannel
-0.042±0.015	¹ ANISOVICH	10	DPWA Multichannel
-0.028	DRECHSEL	07	DPWA $\gamma N \rightarrow \pi N$
-0.045±0.005	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.002±0.003	LI	93	IPWA $\gamma N \rightarrow \pi N$

$\Delta(1905)$ FOOTNOTES

- ¹ ANISOVICH 10 finds an alternate solution for this resonance. The only statistically significant differences are in the Breit-Wigner mass and γp couplings.
- 2 From method II of LONGACRE 75: eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- 3 See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.
- 4 LONGACRE 78 values are from a search for poles in the unitarized T-matrix. The first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis.

$\Delta(1905)$ REFERENCES

For early references, see Physics Letters **111B** 1 (1982).

ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)
WORKMAN	12A	PR C86 015202	R. Workman <i>et al.</i>	(GWU)
ANISOVICH	10	EPJ A44 203	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)
DRECHSEL	07	EPJ A34 69	D. Drechsel, S.S. Kamalov, L. Tiator	(MAINZ, JINR)
DUGGER	07	PR C76 052211	M. Dugger <i>et al.</i>	(Jefferson Lab CLAS Collab.)
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)
PDG	06	JPG 33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)
ARNDT	04	PR C69 035213	R.A. Arndt <i>et al.</i>	(GWU, TRIU)
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT+)
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)
ARNDT	95	PR C52 2120	R.A. Arndt <i>et al.</i>	(VPI, BRCO)
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)
LI	93	PR C47 2759	Z.J. Li <i>et al.</i>	(VPI)
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) IJP
Also		PR D30 904	D.M. Manley <i>et al.</i>	(VPI)
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP
CANDLIN	84	NP B238 477	D.J. Candlin <i>et al.</i>	(EDIN, RAL, LOWC)
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELS, CIT, CERN)
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)
Also		NP B197 365	K. Fujii <i>et al.</i>	(NAGO)
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP
LONGACRE	78	PR D17 1795	R.S. Longacre <i>et al.</i>	(LBL, SLAC)
LONGACRE	75	PL 55B 415	R.S. Longacre <i>et al.</i>	(LBL, SLAC) IJP

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NODE=B011A1

NODE=B011A1

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NODE=B011A2

NODE=B011A2

→ UNCHECKED ←

NODE=B011

NODE=B011M;LINKAGE=AN

NODE=B011;LINKAGE=L5

NODE=B010;LINKAGE=H9

NODE=B011;LINKAGE=L8

NODE=B011

NODE=B011

REFID=54041

REFID=54862

REFID=54335

REFID=53280

REFID=52105

REFID=52039

REFID=51535

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